MULTITEMPORAL ANALYSIS OF THE USE AND LAND COVER IN ISLAND OF MARANHÃO

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Abstract

The process of occupation of the island of Maranhão, has intensified due to the economic, political and social and became worrisome given the fragility of the natural resources to human action. Therefore, the aim of this work was to study the dynamics of landscape and occupation of physical space-territorial Island in the years 1984 and 2010 by means of TM/ Landsat 5. For the image processing was structured a database in GIS, UTM projection, Datum SAD69, using the software SPRING 4.3.3. The images were segmented and subjected to a visual classification. The time series of images showed a trend towards fewer areas of vegetation, particularly in riparian areas (45.5%), secondary forest (17.83%) and mangrove (15.02%). Sandbank areas, depending on the natural dynamics, the changes were less evident (1.5%) It was also observed that the urban area had a high growth rate (143.8%) being distributed over the north central portion of the island. Over the past 26 years, the island had a population growth rate of 112.26%, which represents 84.56% Capital. The results confirm that the analysis of satellite images is an important tool in mapping the use and occupation of land and assist in planning the physical space-territorial island.

1 Introduction

The term geo-processing denotes a discipline of knowledge which uses mathematical and computational techniques for the treatment of geographic information. These techniques become more and more influence in the areas of mapping, analysis of natural resources, transport, communications, energy, urban and regional planning. Originally designed for military purposes, and to assist in the location of minerals, Earth imaging procedures have been becoming progressively in the 1970s, for the purposes of civil engineering, very attached to agriculture and the environment.

Computational tools, such as geographic information systems (GIS), make it possible to develop sophisticated analyses, integrating data from different sources and create geo-referenced databases. Thus it is possible to automate the production of cartographic documents such as those presented in this work. The SIG has gone from being a tool in the decision-making from the academic field, to reach the market faster.

Government institutions and large companies began to invest in the use of applications available on the market, including the SPRING, software provided free of charge by the INPE. There is currently a large increase in the use of GIS in organizations, due to the decrease in hardware and software costs. Also by the emergence of alternatives more cheaper for the construction of geographic databases that facilitate actions such as urban planning, which is the process of creation and development of programs that seek to improve or revitalize certain aspects (such as quality of life) within a specific urban area.

The city of São Luís, capital of Maranhão State, has shown a continuous expansion and diversification in forms of occupation of its physical space by human action. The disorderly growth of the region has collided with the traditional forms of occupation and exploitation of land, water and forest resources, generating greater social inequality, environmental offences, the breakdown of families and the denial of human rights.

Due to the above, there is a need to obtain more specific data to study the dynamics of the landscape and of the occupation of the island, using geo-processing tools that contribute to the monitoring of this expansion, mapping of the areas occupied by the man and the remains of vegetation and its environmental impacts, seeks to improve outcomes through the use of this technology [1].

This study aims to study the dynamics of the landscape and the occupation of the space on the island of Maranhão, during the years 1984 to 2010, through TM/Landsat5 images, as well as to map and quantify the soil use and occupation classes through geo-processing techniques. In this context, the work emerges as a contribution that refreshes and enriches the existing knowledge on urban expansion on this area, at the same time warns about the severity of the current degree of changes in the vegetation of the island and its negative consequences on the environment.

2 Method

Study area

The Island of Maranhão or Upaon Açu is located in the North of the State of Maranhão, Northeast Brazil, framed between the geographic coordinates 2° 24' 10 "and 2° 46' 37" South latitude and 44° 22' 39" and 44° 22' 39" West longitude, an area total approximately 1.410,015 km^2 [2].

The island is divided into four municipalities that make up the metropolitan region of São Luis: Raposa, São Luís, São Jose de Ribamar and Paço do Lumiar [3]. The area is nowadays strongly anthropized; its natural vegetation along these decades has been replaced by housing, derived from the great increase of population of the island, as well as, also has it been cleared for other various applications. There are still areas of mangroves and also extends the appearance of babacuais (secondary vegetation) and a small forest. This vegetation is based on four major types of soil, namely: Red latosols, mangrove indiscriminate soil, Quartzipsamments neossolos and ultisols [4]

According to IBGE [2], the municipality of São Luís in 2010 had a population of 1.027.098 habitants, being the most populous island municipality in 2010. The climate of the region, according to the Köppen classification is of type Aw´, rainy, tropical with rains in the months of January to April and this is due to the fact that the city is located next to the area of Inter-tropical Convergence (ITCZ) and annual average temperature oscillates around 28°C. The hydrography of the island have as main rivers Anil, Bacanga, Tibiri, Paciência, Maracanã, Calhau, Pimenta, Coqueiro e Cachorros. They are small rivers that feed in areas of dunes, beaches and mangroves. The two largest, rivers are the Anil with 12.63 km long and Bacanga with 22 km to its mouth [5], in the Bahia de São Marcos in their areas covered with mangrove estuaries.

Work methodology

For the development of the work, we use the software Spring 4.3, images in digital format, composition of 3, 4 and 5 bands, spectral resolution (30x30m), orbit/ponto 220/062 dates of 20/06/84 up to 02/04/10, generated by the Landsat5 satellite related with the area of study, a total of a timeline of 26 years.

With the help of the software we created a database, which generates the project and has delimited with an enveloping rectangle, also were created the categories and then the Planes of Information (PI). The images were geo-referenced using as a basis a mosaic of images of the State of Maranhão. With these procedures, work by importing images, and then the interpretation of them to have a better job in the interpretation of the data, the images received a contrast suitable for work. Then became a segmentation using the method of growth, similarity = 15 regions and area (pixels) = 30.

After edit vectors, which corresponded to the category of use and coverage, is qualified to obtain the entirety of polygons using the function measures of the thematic classes in the SPRING menu bar. Finally, share the letters that were exported in the format postscrip (ps); This file has been imported and edited to improve the finish of CorelDRAW X 5 maps with a scale of work E 1: 100.000.

3 Results and Discussion

Multi-temporal analysis of the images between 1984 and 2010, it was possible to detect the urban expansion in the area of study and those areas were converted into percentages of occupation of the area studied. Through the measure of the SPRING class, two classes of plans for information were compared and it was possible to make the calculation of the areas of each polygon class km^2.

Maps

The maps generated from the information obtained by the images, demonstrate the advancement of this evolutionary process on urban expansion on the island of Maranhão, already described in figures 1 and 2.

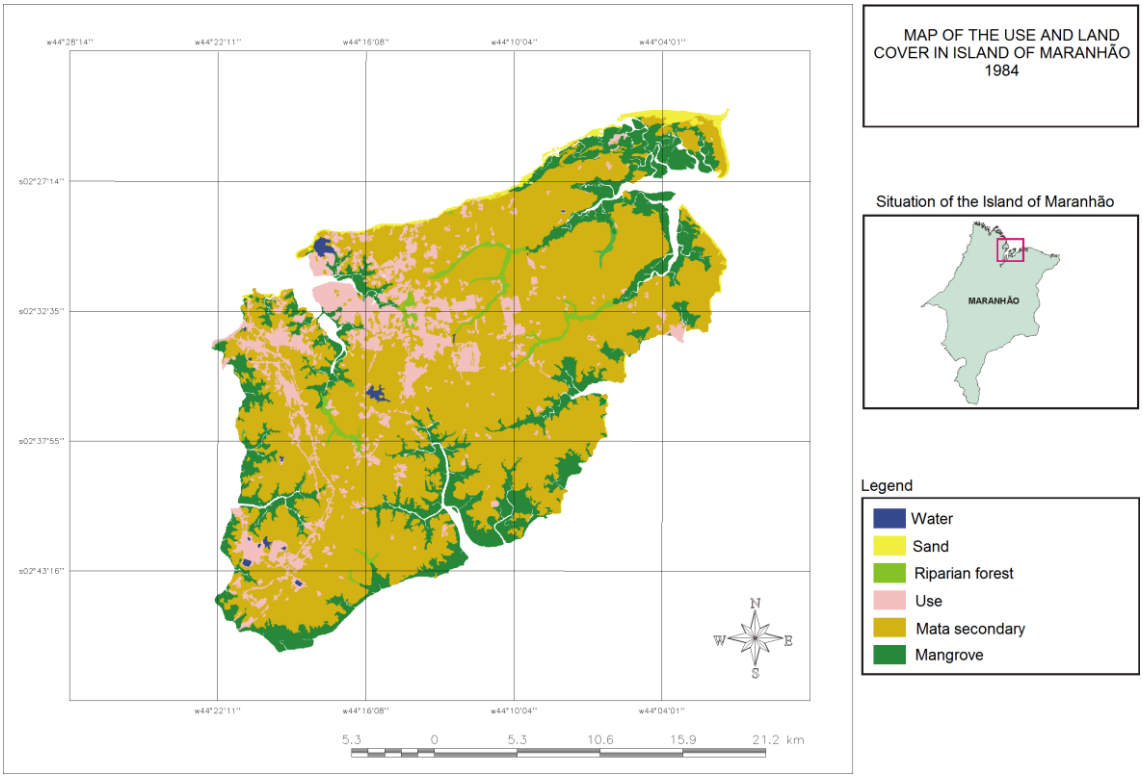

Fig.1 Map of the use and land cover in island of Maranhão (1984)

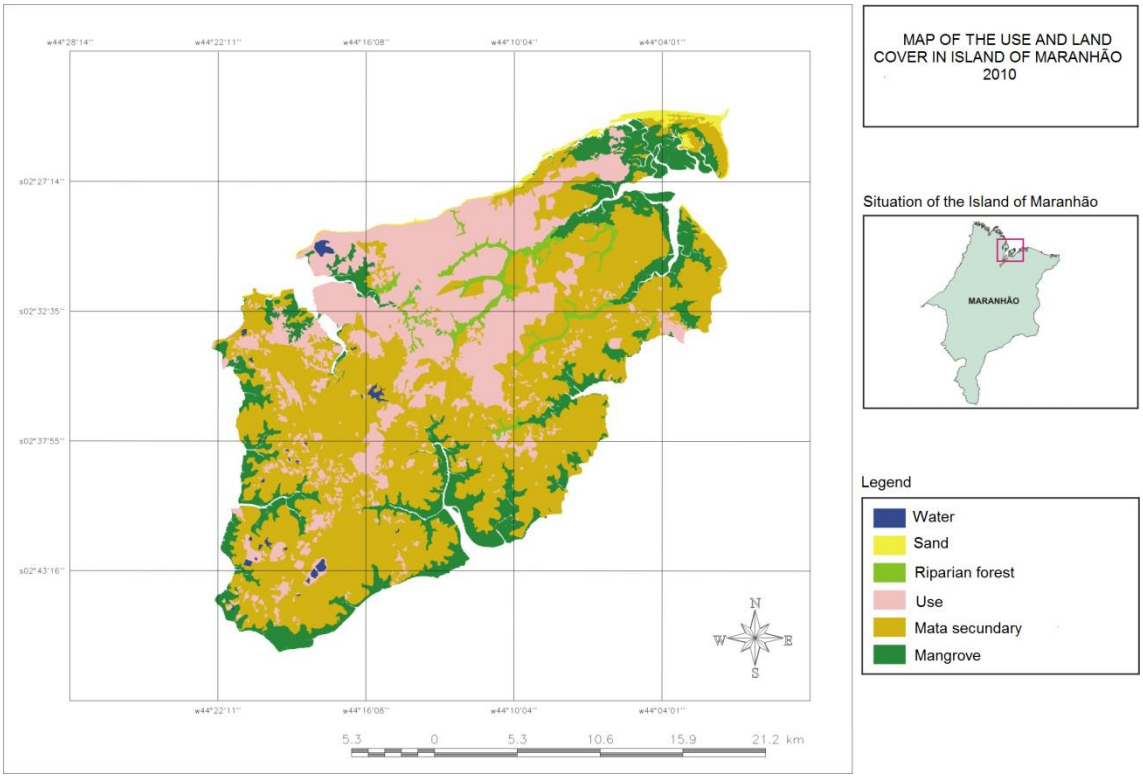

Fig. 2 Map of the use and land cover in island of Maranhão (2010)

Many of the neighbourhoods had their territory invaded by families from the interior of the State, and had no place to settle. Due to the lack of planning in the Organization of these neighborhoods, these began to present several problems of a structural nature due to due to the lack of basic infrastructure and a quality educational system.

This phenomenon may be the result of advances in the projects of industrialization which intensified the process of urban occupation of the island, mainly in Sao Luis, capital of Maranhão, which in 2010 reached 1.011.943 habitants, distributed in an area of only 828.19 Km². Between the years of 1984 and 2010, the island has a rate of growth of the population of 112.26%, of whom represented capital 84.56%.

These new arrivals have managed to occupy spaces that used to have a complete vegetation cover. One of the greatest examples to quote is Cidade Olímpica, considered the second largest urban occupation of Latin America with around 65 thousand habitants [6], and now with a population of 140.000 habitants

The floras of forests and mangroves, the dominant in the past, have suffered constant transformations from speculation or even by excessive extraction of resources, which has caused a serious environmental imbalance. This process slowly triggered the destruction accelerated in these ecosystems, being replaced or modified by human action. The landscapes that were covered with plants in the past, much of the territory, during the period of 26 years between 1984 and 2010 (figures 1 and 2), have given way to built-up areas, exposed soil and or lots as shown in table 1, with areas of considerable reduction of vegetation cover, especially in the areas of vegetation riparian (45.5%), Secondary vegetation (17.83%) and mangrove (15.02%). In Restinga areas, due to the natural dynamics, changes were very little (1.5%).

In the city of São Luís, the expansion of urban areas can see along the BR-135, due to the growth of the industrial zone. Also starting from the center of the island to the Northeast along the coast to the town of Raposa, the growth of neighborhoods such as Divinéia, Santa Rosa, Araçagy e Vila Luizão besides communities and lots have contributed to the sprawl of the island. This continuous expansion of urban areas has contributed to presented a high rate of growth (143.8%) distributed more in the Center-North of the island.

Classification	Area (km²)		Area Percentage (%)		Rage of Change (%)
	1984	2010	1984	2010	
Mangrove	164,79	140,03	18,15	15,42	-15,02
Secondary Vegetation	603,27	495,74	66,44	54,60	-17,83
Urban Core	99,11	241,64	10,92	26,61	143,80
Riparian Forest	11,50	6,27	1,27	0,69	-45,50
Sand	10,94	5,42	1,20	0,60	-50,45
Water Bodies	6,34	6,42	0,70	0,71	1,15
Settling Ponds	0,52	1,14	0,06	0,13	118,59
Restinga	11,51	11,35	1,27	1,25	-1,46
Total	908,00	908,00	100,00	100,00	

Table 1. Quantification of areas use and land cover and its variations

The creation of housing estates such as Cohatrac, Maiobão, Jeniparana, Tambaú, city worker, among others was a decisive factor making it in patience, Santo Antonio basin e North Coast (Figure 3), the urbanization occurred in areas of maximum gradient, which causes problems of siltation and pollution from domestic sewage [7].

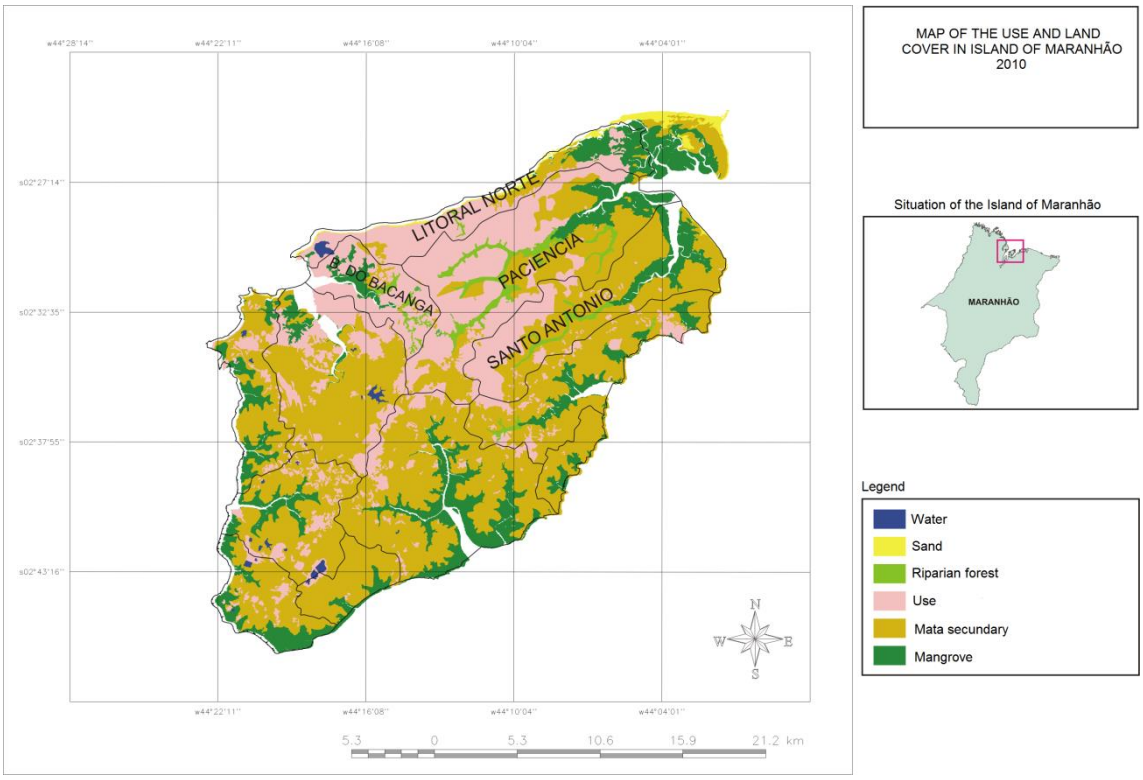

Fig. 3 Urban sprawl in the main hydrographic basins of the island of Maranhão (2010)

4 Conclusion

Based on the analysis, discussion and interpretation of results, the following considerations were obtained:

- The used Geo-technology shows its efficiency in the development and application of methods (management systems) and monitoring the evolutionary dynamics in processes of urban expansion, as well as their environmental, social and economic impacts related to the disordered occupation of the space on the island of Maranhão.
- The disordered occupation of the soil on the island and population growth have led to environmental degradation, this amplifies the risk of decrease in quality of life.
- From the evidence shown in this study, we realize how worrisome is the process of occupation and use of land in the island of Maranhão.
- We have noted that during these 26 years, there is an expansion of built-up areas that contribute to a high rate of population growth (143.8%).
- On the other hand, we observed a reduction considerable in the areas of coverage plant, especially in the areas of vegetation riparian (45.50%), Secondary vegetation (17.83%) and mangrove (15.02%). Restinga areas, due to the natural dynamics, changes were very little (1.5%).

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